PATENT SPECIFICATION

DRAWINGS ATTACHED

882,989

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COMPLETE SPECIFICATION

Device for Measuring Forces

We, CARL SCHENCK MASCHINENFABRIK G.M.B.H., of 55, Landwehrstrasse, Darmstadt, Germany, a body corporate organised under the Laws of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a device employing strain gauges, for measuring forces.

Various kinds of devices have already been proposed for measuring forces. Owing to their structural simplicity and the possibility they offer of directly transmitting the measured quantities in a simple way to evaluating means remote from the point of actual measurement, such so-called electrical strain gauge dynamometers have become increasingly popular. They consist substantially of a measuring element which is deformed by tension or compression, the deformational deflection when under load producing changes in the electrical resistance of strain gauges affixed to the element, so that their resistance can be used as a measure of the momentary load. Known measuring elements have the form of bars and cylinders which can be axially strained.

It is a peculiarity and usually an advantage of the aforedescribed strain gauge dynamometers that they permit measurements to be performed by a method which requires practically no displacement or deflection. However, sudden loads, possibly due to inadvertence or other causes, may give rise to forces which far exceed the measuring range of such a dynamometer device. Generally, any such overload will damage or even destroy the device. This risk is especially great for instance in the operation of cranes because sudden uncontrolled forces may be set up when the hook is caught by an obstacle or loads are raised with a sudden jerk. The provision of deflectional limit stops as a safeguard against destruction by overload is quite impracticable in such dynamometers because the deflection is much too small.

As a precaution the measuring range of a dynamometer is therefore sometimes only partially used. In other words, only part of the available range of the dynamometer is actually utilised for measuring under normal conditions, the remainder of the measuring range being left as a safety range to provide a margin for possible overloads. This is a disadvantage inasmuch as the magnitude of the possible overload can only be estimated so that even the safety range may be exceeded with the afore-described undesirable consequences. The reduction of the measuring range necessarily involves a reduction in the accuracy of the measurement because some errors are absolute quantities which are not proportional to the forces measured by the device.

The present invention aims at obviating the afore-described drawbacks. This object is achieved, according to the invention, by the interposition, between a structural member for transmitting the force and a structural member which serves as an abutment, of two or more substantially U-shaped elastic measuring elements each of which carries strain gauges on its arched portion which connects the two shanks, in such manner that the point of application of the force to said measuring elements is near the free end of their shanks. A device constructed in accordance with the invention will have an adequate degree of stability and, despite a low structural height of the measuring elements, the deflection will be sufficiently large to permit the employment of functionally practicable deflection limiting abutment means.

The dynamometer device in accordance with the invention may be used for measuring tensile loads as well as of compressional loads if known load reversing means are employed such as elements engaging in the manner of chain links or if the shaft of the crane hook is arranged to pass slidably through the cross bar.

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The individual measuring elements may be affixed or clamped between the structural members in any desirable manner. Alternatively, they may be integral with said structural members, possibly even including the deflection limiting abutments. If the measuring elements are detachably affixed to the structural members it is a simple matter, without increasing the structural height, to increase the available measuring range by interpolating a greater number of measuring elements. It is also quite possible to machine the several parts and even the entire dynamometer device out of one solid blank, for instance by milling, drilling, and like operations.

According to another feature of the invention the deflection limiting abutments may be so contrived that they will at the same time limit lateral displacement of the measuring elements.

Still a further feature of the invention is to provide flexible joints in the measuring elements by forming constrictions therein which, especially near the point of application of the measured load, improve the deformational deflection at the points where the strain gauges have been affixed. A particularly satisfactory measuring effect can thus be achieved.

Embodiments of the invention are illustrated diagrammatically and by way of example in the accompanying drawings in which like parts are denoted by like reference numerals.

Fig. 1 shows a device for measuring a compressional load, comprising two dynamometer loops 1, 2 interposed between a structural member 3 resting on the cross bar of a crane hook or formed on the cross bar itself, through which the hook 4 passes, and a member 5 affixed to the crane hook or otherwise subjected to the load on the hook. Member 3 is formed in such a way as to provide an abutment 3^1 which limits the deformation of the dynamometers loops. The load depending from the crane hook 4 acts on the dynamometer loops 1, 2 and compresses them, the maximum deflection a of the loops being determined by the position of the abutment 3^1. Strain gauges 6, 7 are affixed to the arcuate portions of the loops, strain gauge 6 being elongated and strain gauge 7 compressed when under load. The strain gauges may consist of any known type of gauge for electrically measuring compressional and elongational strain, for instance passive elements based upon the change in resistance of an electrical conductor such as wire or foil, strips of electrical resistance or semi-conductor material, or they may be active elements based upon the piezo-electrical effect of a material.

Fig. 2 is a plan view of a device in which more than two dynamometer loops 1, 1^1, 1^{11}. 2, 2^1, 2^{11} are arranged to form a star.

Fig. 3 shows a device in which the dynamometer loops and the abutments are of one-piece construction.

According to Fig. 4 the dynamometer loops 1, 2 are formed from a single piece of material by machining appropriate holes and slots into the same. At points 8 the cross-section of the loops 1, 2 is reduced, thus forming a kind of flexible joint. In such a form of construction the greatest amount of deformation will be experienced in the regions where the strain gauges 6 and 7 are attached.

The embodiment shown in Fig. 5 substantially corresponds with that illustrated in Fig. 1. The latter arrangement is here modified in that abutment 5^1 is affixed to member 5 and shaped at point 5^{11} in such a way that in addition to limiting the deflection it will at the same time limit any lateral displacement. In a manner analogous to the embodiment shown in Fig. 4 flexible joints 8 are likewise provided.

Fig. 6 illustrates an embodiment in which the loops and structural members are formed from one piece of material.

The illustrated embodiments can be used in known manner for measuring compressional loads, for instance as illustratively shown in Fig. 1, or they may be used for measuring tensile loads. In the latter case the abutments must be appropriately modified.

WHAT WE CLAIM IS:—

1). A device equipped with strain gauges for measuring forces, in which two or more substantially U-shaped elastic measuring loops are interposed between a structural member transmitting the force and a structural member forming an abutment, said measuring loops being so disposed that the forces will act upon them near the free end of their shanks and that each of the arcuate portions which connect the respective shanks of the loops has strain gauges affixed thereto.

2). A device as claimed in Claim 1, in which an abutment is provided for limiting the relative deflection of the two structural members.

3). A device as claimed in Claim 1, in which the measuring loops are formed with constrictions, preferably in their shanks near the point of application of the load.

4). A device as claimed in any of Claims 1 to 3, in which the measuring loops or structural members are machined from the solid by machining openings or bore-holes from a blank.

5). A device as claimed in any of Claims 1 to 4, in which the structural members, measuring loops and/or abutments are all formed from one blank.

6). Device for measuring forces, substantially as hereinbefore described with reference to the accompanying drawings.

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Fig. 1

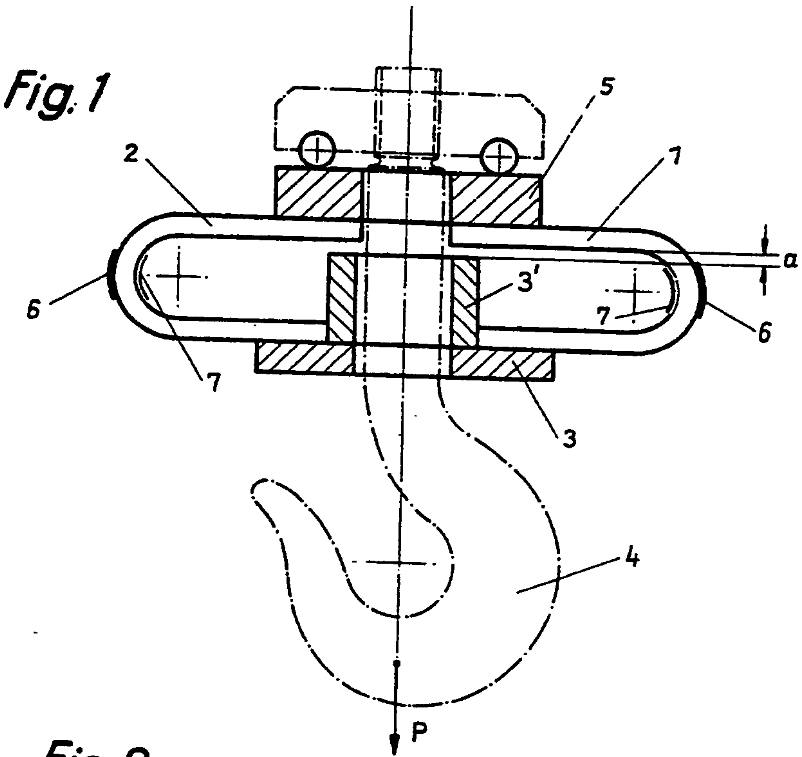
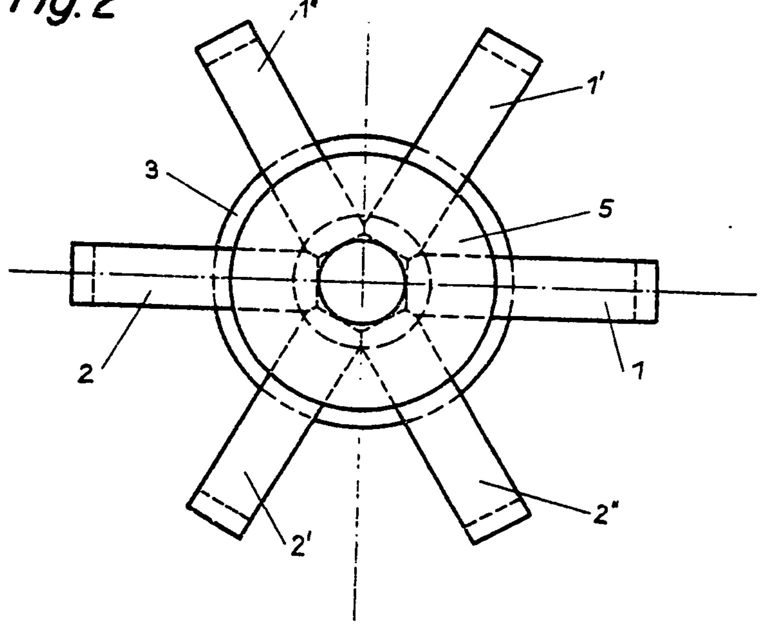


Fig. 2



882,989 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEETS 1 & 2

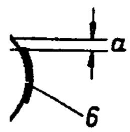


Fig. 3

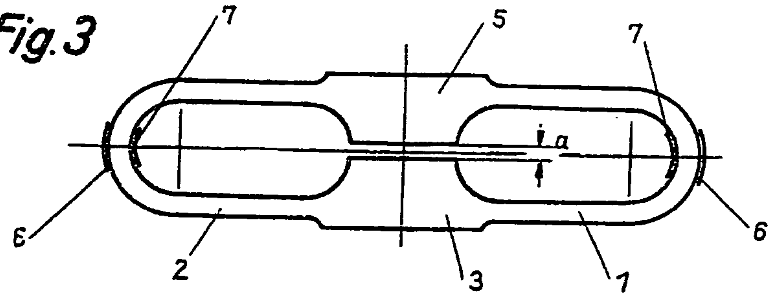


Fig. 4

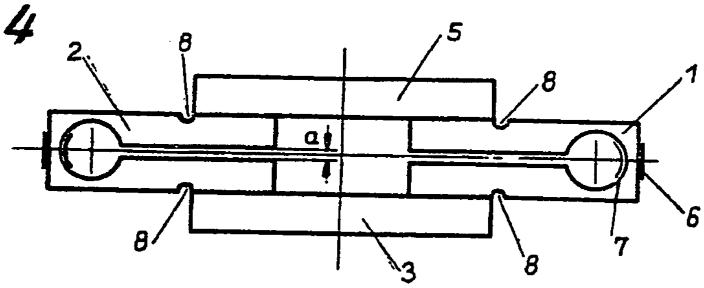


Fig. 5

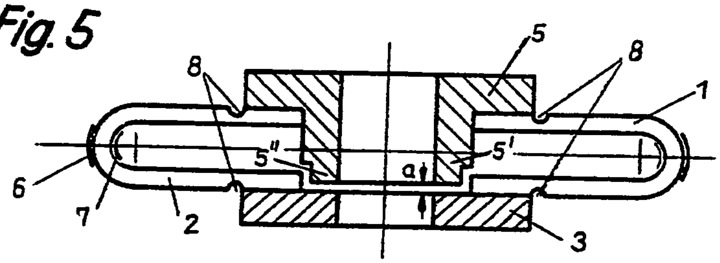
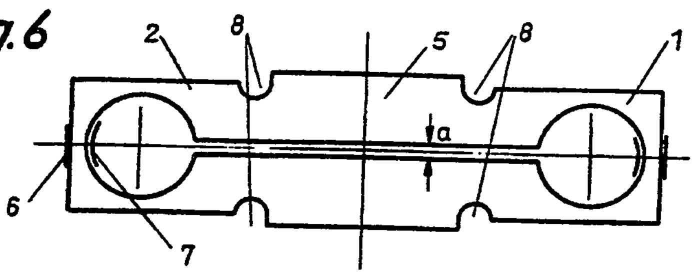


Fig. 6



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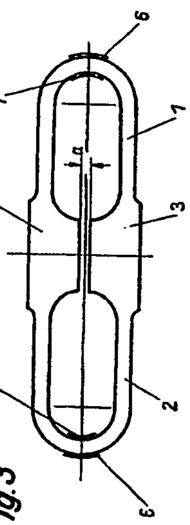

Fig.3

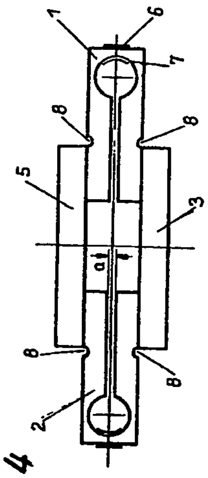

Fig.4

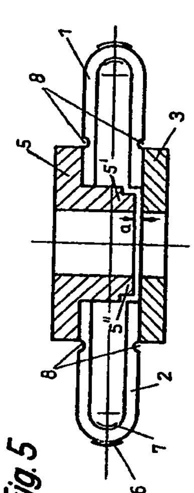

Fig.5

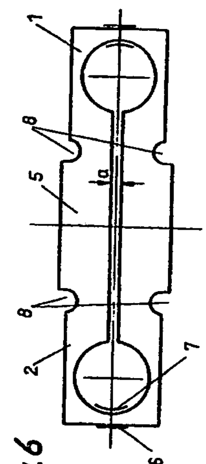

Fig.6

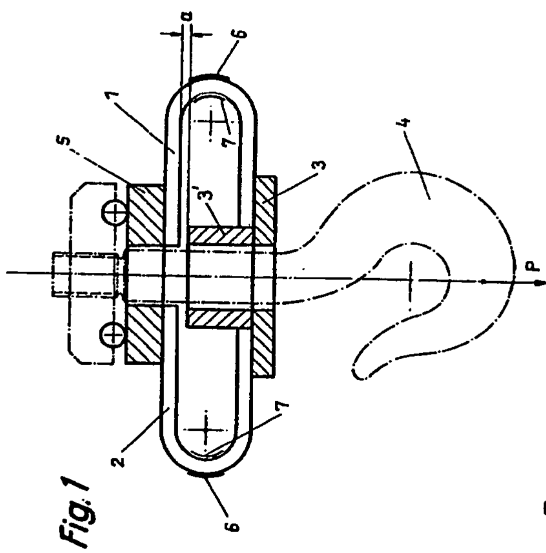

Fig.1

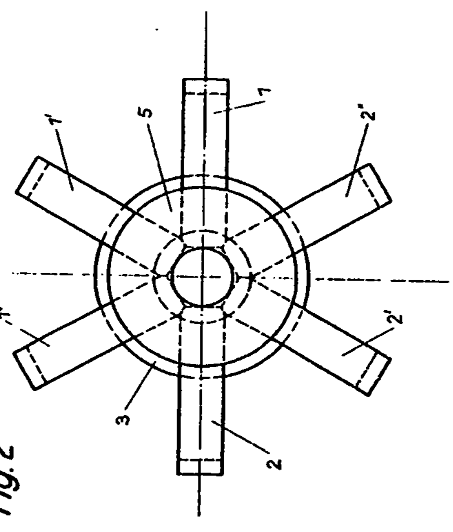

Fig.2

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Applic. #

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